

TITLE OF THE INVENTION

Inv. 217 ~~IMAGE SENSING APPARATUS~~

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BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

The present invention relates to an image sensing apparatus for sensing a still image and/or moving image.

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DESCRIPTION OF THE RELATED ART

Conventionally, image sensing apparatuses such as electronic cameras and the like, which record/play back still images and moving images sensed by a solid-state image sensing element such as a CCD or the like using memory cards having solid-state memory elements as recording media, have already been commercially available.

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Furthermore, another electronic still camera senses images by selectively using one of an aperture (Av) priority image sensing mode for automatically increasing/decreasing the shutter speed to obtain an appropriate exposure value in correspondence with an arbitrarily selected aperture value, and a shutter speed (Tv) priority mode for automatically increasing/decreasing the aperture value to obtain an

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appropriate exposure value in correspondence with an arbitrarily selected shutter speed.

Moreover, still another electronic still camera comprises an AEB (auto exposure bracketing) image sensing mode that automatically brackets three frames with a standard exposure value, overexposure value, and underexposure value during single image sensing operation. Such cameras enable the photographer to easily obtain an appropriate exposure value upon image sensing under complicated light conditions or upon image sensing using an electronic camera that comprises an image sensing element with a narrow latitude.

Upon image sensing using a solid-state image sensing element such as a CCD or the like, a dark noise correction process is done by computations using dark image data which is read out after charge accumulation in the same manner as in actual image sensing while the image sensing element is not exposed, and actually sensed image data which is read out after charge accumulation while the image sensing element is exposed.

With this process, sensed image data can be corrected for image quality deterioration such as pixel omission or the like caused by dark current noise produced by the image sensing element and small scratches unique to the image sensing element, thus obtaining high-quality sensed image data.

Especially, since dark current noise increases with increasing charge accumulation time and temperature rise of the image sensing element, if exposure for a long period of time (seconds) or at high temperature is done, a great image quality improvement effect can be obtained, and the dark noise correction process is a function useful for the electronic camera users.

In this manner, since dark current noise increases with increasing charge accumulation time and temperature rise of the image sensing element, the charge accumulation time of the image sensing element for capturing the dark image data must be determined in correspondence with the shutter speed (Tv value) obtained by exposure measurement.

On the other hand, when AEB image sensing is done in the aperture (Av) priority image sensing mode, the shutter speed must be changed for each frame upon automatic bracketing for three frames.

Therefore, in an image sensing apparatus such as an electronic camera, when the shutter speed has changed, a new charge accumulation time is set. When the charge accumulation time has been changed, the dark image must be re-captured. That is, upon executing automatic sequential exposure image sensing for three

frames, the dark image must be re-captured every actual image sensing.

For this reason, when continuous-shot AEB image sensing is done in the aperture (Av) priority image sensing mode, the dark image must be captured three times upon sensing each of frames to be continuously sensed, and the image sensing interval for each frame upon continuous shot image sensing is prolonged by the dark image sensing time, and the shutter release time lag becomes longer by the dark image sensing time, thus making the user miss a shutter chance or reducing the continuous shot frame speed.

SUMMARY OF THE INVENTION

One aspect of the present invention is to provide an apparatus, which comprises an image sensing device, a signal processing device for performing a first image sensing operation for making the image sensing device perform an image sensing operation in an exposure state to obtain a sensed image signal, and a second image sensing operation for making the image sensing device perform an image sensing operation in accordance with the first image sensing operation in a non-exposure state to obtain a sensed image signal, and processing the sensed image signal obtained by the first image sensing operation by the sensed image signal obtained

by the second image sensing operation, wherein the
signal processing device changes method of the second
image sensing operation to the first image sensing
operation in response to the instruction of the
5 instruction device, and an instruction device for
instructing to execute a predetermined plurality times
of image sensing operations with different image
sensing times of the first image sensing operation,
whereby the apparatus can prevent a shutter chance from
10 being missed, and can prevent low continuous shot frame
speed.

Other aspects of the present invention will be
apparent from the following description taken in
conjunction with the accompanying drawings, in which
15 like reference characters designate the same or similar
parts throughout the figures thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram showing the arrangement
20 of an image sensing apparatus according to an
embodiment of the present invention;

Fig. 2 is a flow chart of a main routine showing
the control sequence of the image processing apparatus;

Fig. 3 is a flow chart of the main routine
25 showing the control sequence of the image processing
apparatus and continued from Fig. 2;

Fig. 4 is a flow chart of the main routine showing the control sequence of the image processing apparatus and continued from Fig. 3;

Fig. 5 is a flow chart of the main routine
5 showing the control sequence of the image processing apparatus and continued from Fig. 4;

Fig. 6 is a flow chart of the main routine showing the control sequence of the image processing apparatus and continued from Fig. 5;

10 Fig. 7 is a flow chart showing the detailed sequence of the distance measurement/photometry process in step S134 in Fig. 4;

Fig. 8 is a flow chart showing the detailed sequence of the image sensing process in step S164 in
15 Fig. 4;

Fig. 9 is a flow chart showing the detailed sequence of the dark capture process in step S140 in Fig. 4 and in step S167 in Fig. 5; and

Fig. 10 is a timing chart showing the flow of
20 image sensing operation in the image sensing apparatus.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

A preferred embodiment of the present invention will be described hereinafter with reference to the
25 accompanying drawings.

Fig. 1 is a block diagram showing the arrangement of an image sensing apparatus according to an embodiment of the present invention.

Referring to Fig. 1, reference numeral 100
5 denotes an image processing apparatus.

Reference numeral 12 denotes a shutter for controlling the exposure amount on an image sensing element 14; and 14, an image sensing element for converting an optical image into an electrical signal.

10 Light rays that have entered a lens 310 are guided onto the image sensing element 14 via a stop 312, lens mounts 306 and 106, a mirror 130, and the shutter 12 by a single-lens reflex system, and form an optical image on the image sensing element 14.

15 Reference numeral 16 denotes an A/D converter for converting an analog signal output from the image sensing element 14 into a digital signal.

Reference numeral 18 denotes a timing generation circuit for supplying clock signals and control signals
20 to the image sensing element 14, the A/D converter 16, and a D/A converter 26. The timing generation circuit 18 is controlled by a memory control circuit 22 and system control circuit 50.

Reference numeral 20 denotes an image processing
25 circuit for performing a predetermined pixel interpolation process and color conversion process for

data from the A/D converter 16 or the memory control circuit 22.

Also, the image processing circuit 20 can execute a TTL (through the lens) AF (auto-focus) process, AE (auto-exposure) process, and EF (flash light control) process. In these processes, the image processing circuit 20 makes predetermined computations using sensed image data as needed, and the system control circuit 50 controls an exposure (shutter) control circuit 40 and distance measurement circuit 42 on the basis of the obtained computation result.

Furthermore, the image processing circuit 20 makes predetermined computations using sensed image data, and executes a TTL AWB (auto white balance) process on the basis of the obtained computation result.

Since this embodiment comprises the distance measurement circuit 42 and a photometry circuit 46 dedicated to those processes, the AF, AE, and EF processes may be done using the distance measurement circuit 42 and photometry circuit 46 in place of those using the image processing circuit 20.

Alternatively, the AF, AE, and EF processes may be done using the distance measurement circuit 42 and photometry circuit 46 in addition to those using the image processing circuit 20.

Reference numeral 22 denotes a memory control circuit which controls the A/D converter 16, the timing generation circuit 18, the image processing circuit 20, an image display memory 24, the D/A converter 26, a
5 memory 30, and a compression/expansion circuit 32.

Data output from the A/D converter 16 is written in the image display memory 24 or memory 30 via the image processing circuit 20 and memory control circuit 22 or via the memory control circuit 22 alone.

10 Reference numeral 24 denotes an image display memory; 26, a D/A converter; and 28, an image display unit comprising, e.g., a TFT LCD or the like. Display image data written in the image display memory 24 is displayed on the image display unit 28 via the D/A
15 converter 26.

When sensed image data is displayed using the image display unit 28 as needed, an electronic viewfinder function can be implemented.

The image display unit 28 can turn on/off its
20 display in accordance with an instruction from the system control circuit 50. When the display is OFF, great power savings of the image processing apparatus 100 can be achieved.

Reference numeral 30 denotes a memory for storing
25 sensed still or moving images. The memory 30 has a sufficient memory size capable of storing a

predetermined number of still images or a moving image
for a predetermined period of time. Hence, even in a
continuous shot mode or panorama mode for continuously
sensing a plurality of still images, a large number of
5 images can be written in the memory 30 at high speed.

Also, the memory 30 can be used as a work area of
the system control circuit 50.

Reference numeral 32 denotes a
compression/expansion circuit for compressing/expanding
10 image data by the adaptive discrete cosine transform
(ADCT), or the like. The compression/expansion circuit
32 loads an image stored in the memory 30, compresses
or expands it, and writes the compressed or expanded
data in the memory 30.

15 Reference numeral 40 denotes a shutter control
circuit for controlling the shutter 12 on the basis of
photometry information from the photometry circuit 46
in cooperation with a stop control circuit 340 that
controls the stop 312.

20 Reference numeral 42 denotes a distance
measurement circuit used to execute the AF process.
Light rays that have entered the lens 310 are guided to
the distance measurement circuit 42 via the stop 312,
the lens mounts 306 and 106, the mirror 130, and a
25 distance measurement sub-mirror (not shown) by the

single-lens reflex system, thus measuring the focusing state of an image formed as an optical image.

Reference numeral 46 denotes a photometry circuit used to execute the AE process. Light rays that have entered the lens 310 are guided to the photometry circuit 46 via the stop 312, the lens mounts 306 and 106, the mirror 130 and a mirror 132, and a photometry lens (not shown), thus measuring the exposure state of an image formed as an optical image.

The photometry circuit 46 also has an EF process function in cooperation with an electronic flash 48.

Reference numeral 48 denotes an electronic flash which has a function of projecting AF assist light, and a flash light control function.

Note that the system control circuit 50 can perform exposure control and AF control using a video TTL scheme for the shutter control circuit 40, stop control circuit 340, and distance measurement control circuit 342 on the basis of the computation result of image data output from the image sensing element 14 by the image processing circuit 20.

Furthermore, AF control may be done using both the measurement result of the distance measurement circuit 42 and the computation result of image data output from the image sensing element 14 by the image processing circuit 20.

Moreover, exposure control may be done using both the measurement result of the photometry circuit 46 and the computation result of image data output from the image sensing element 14 by the image processing
5 circuit 20.

Reference numeral 50 denotes a system control circuit for controlling the overall image processing apparatus 100; and 52, a memory for storing constants, variables, programs, and the like required for
10 operating the system control circuit 50.

Reference numeral 54 denotes an indication unit which comprises a liquid crystal display device, loudspeaker, and the like, and indicates the operation state, messages, and the like using characters, images,
15 sound, and the like in accordance with execution of programs in the system control circuit 50. The indication unit 54 is set at one or a plurality of easy-to-see positions around the console of the image processing apparatus 100, and is constructed by a
20 combination of an LCD, LEDs, sound generation element, and the like. Some functions of the indication unit 54 are set within an optical viewfinder 104.

Of the indication contents of the indication unit 54, those displayed on the LCD or the like include,
25 e.g., a single/continuous shot indication, self timer indication, compression ratio indication, recording

pixel count indicating, recorded image count indication,
remaining recordable image count indication, shutter
speed indication, aperture value indication, exposure
correction indication, flash indication, red-eye
5 suppression indication, macro image sensing indication,
buzzer setup indication, remaining timepiece battery
capacity indication, remaining battery capacity
indication, error indication, information indication
using numerals of a plurality of digits,
10 attachment/detachment indication of recording media 200
and 210, attachment/detachment indication of a lens
unit 300, communication I/F operation indication,
date/time indication, connection indication with an
external computer, and the like.

15 Of the indication contents of the indication unit
54, those displayed within the optical viewfinder 104
include, e.g., in-focus indication, image sensing ready
indication, camera shake alert indication, flash
charging indication, flash charging completion
20 indication, shutter speed indication, aperture value
indication, exposure correction indication, recording
medium write access indication, and the like.

Furthermore, of the indication contents of the
indication unit 54, those displayed using the LEDs and
25 the like include, e.g., in-focus indication, image
sensing ready indication, camera shake alert indication,

flash charging indication, flash charging completion indication, recording medium write access indication, macro image sensing setup notification, secondary battery charging state indication, and the like.

5 Of the indication contents of the indication unit 54, those indicated by lamps and the like include, e.g., a self timer notification lamp, and the like. The self timer notification lamp may be commonly used as AF assist light.

10 Reference numeral 56 denotes an electrically erasable/programmable nonvolatile memory, which uses, e.g., an EEPROM or the like.

Reference numerals 60, 62, 64, 66, 68, and 70 denote operation units for inputting various operation
15 instructions of a system control circuit 118. These operation units are constructed by one or a plurality of combinations of a switch, a dial, a touch panel, a pointer using line of sight detection, a voice recognition device, and the like.

20 Examples of these operation units will be explained below.

Reference numeral 60 denotes a mode dial switch which can selectively set one of various function image sensing modes: an automatic image sensing mode,
25 programmed image sensing mode, shutter speed priority image sensing mode, aperture priority image sensing

mode, manual image sensing mode, focal depth priority
(depth) image sensing mode, portrait image sensing mode,
landscape image sensing mode, macro image sensing mode,
sport image sensing mode, night scene image sensing
5 mode, panorama image sensing mode, and the like.

Reference numeral 62 denotes a shutter switch SW1,
which is turned on in the middle (half stroke position)
of operation of a shutter button (not shown), and
instructs start of the AF (auto-focus) process, AE
10 (auto-exposure) process, AWB (auto white balance)
process, EF (flash light control) process, and the like.

Reference numeral 64 denotes a shutter switch SW2,
which is turned on upon completion of operation (at the
full stroke position) of the shutter button (not shown),
15 and instructs start of a series of processes including
an exposure process for writing a signal read out from
the image sensing element 14 as image data in the
memory 30 via the A/D converter 16 and memory control
circuit 22, a development process using computation
20 results in the image processing circuit 20 and memory
control circuit 22, and a recording process for reading
out image data from the memory 30, compressing the
readout data by the compression/expansion circuit 32,
and writing the compressed image data in the recording
25 medium 200 or 210.

Reference numeral 66 denotes an AEB (auto exposure bracketing) setup switch which is used to set an AEB image sensing mode that automatically brackets three frames with a standard exposure value, overexposure value, and underexposure value during single image sensing operation, and also to set a correction step value in this mode.

Note that the correction step value can be set more smoothly if plus and minus buttons or a rotary dial switch is used.

Reference numeral 68 denotes a single/continuous shot switch, which can set one of a single shot mode for sensing one frame of image upon depression of the shutter switch SW2, and then setting a standby state, and a continuous shot mode for successively sensing images while the shutter switch SW2 is held down.

Reference numeral 70 denotes a console including various buttons, touch panel, and the like, which include a menu button, set button, macro button, multi-frame playback new page button, flash setup button, single shot/continuous shot/self timer switch button, menu move + (plus) button, menu move - (minus) button, playback image move + (plus) button, playback image move - (minus) button, sensed image quality select button, exposure correct button, date/time setup button, select/change button that can select and change

various functions upon executing image sensing and playback in, e.g., the panoramic mode, determine/execute button which can determine and execute various functions upon executing image sensing and playback in, e.g., the panoramic mode, image display ON/OFF switch for turning on/off the image display unit 28, quick review ON/OFF setup switch for setting a quick review function of automatically playing back sensed image data immediately after image sensing, compression mode switch for selecting a compression ratio of JPEG compression, and selecting a CCDRAW mode for directly converting a signal output from the image sensing element into digital data, and recording the digital data in a recording medium, playback mode switch for setting various function modes such as a playback mode, multi-frame playback/delete mode, PC connect mode, and the like, AF mode setup switch which can set a one-shot AE mode for starting auto-focusing upon depression of the shutter switch SW1, and maintaining an in-focus state once it is attained, and a servo AF mode for continuously executing auto-focusing while the shutter switch SW1 is held down, playback switch which instructs to start playback operation for reading out an image sensed in a given image sensing mode from one of the memory 30 and the

recording media 200 and 210, and displaying the readout image on the image display unit 28, and the like.

In place of the plus and minus buttons, a rotary dial switch may be used to select numerical values and functions more smoothly.

Reference numeral 72 denotes a power switch which can selectively set power-ON and power-OFF modes of the image processing apparatus 100. Also, the power switch 72 can also selectively set power-ON and power-OFF modes of various accessories such as the lens unit 300, external electronic flash, recording media 200 and 210, and the like, which are connected to the image processing apparatus 100.

Reference numeral 80 denotes a power supply control circuit which is comprised of a battery detection circuit, a DC-DC converter, a switch circuit for switching a block to be energized, and the like. The power supply control circuit 80 detects the presence/absence, type, and remaining battery amount of the battery attached, controls the DC-DC converter on the basis of such detection results and an instruction from the system control circuit 50, and supplies a required voltage to the respective units including the recording media for a required period of time.

Reference numerals 82 and 84 denote connectors; and 86, a power supply circuit. The power supply

circuit 86 includes a primary battery such as an alkali battery, lithium battery, or the like, a secondary battery such as an NiCd battery, NiMH battery, Li battery, or the like, an AC adapter, and the like.

5 Reference numerals 90 and 94 denote interfaces with recording media such as a memory card, hard disk, and the like; 92 and 96, connectors for connecting recording media such as a memory card, hard disk, and the like; and 98, a recording medium

10 attachment/detachment detection circuit for detecting whether or not the recording medium 200 or 210 is attached to the connector 92 and/or the connector 96.

 Note that this embodiment has two sets of interfaces and connectors that receive the recording
15 media. However, the number of sets of interfaces and connectors that receive the recording media is not particularly limited. Also, combinations of interfaces and connectors of different standards may be used.

 As the interface and connector, those complying
20 with the standards of a PCMCIA card, CF (compact flash) card, and the like may be used.

 Furthermore, when the interfaces 90 and 94, and connectors 92 and 96 use those complying with the standards of a PCMCIA card, CF (compact flash) card,
25 and the like, and various communication cards such as a LAN card, modem card, USB card, IEEE1394 card, P1284

card, SCSI card, PHS, and the like are connected thereto, image data and associated management information can be transferred between the image processing apparatus and an external computer or its peripheral devices such as a printer and the like.

Reference numeral 104 denotes an optical viewfinder which can guide light rays that have entered the lens 310 via the stop 312, lens mounts 306 and 106, and mirrors 130 and 132 by the single-lens reflex system, and can form and display them as an optical image. In this manner, without using the electronic viewfinder function implemented by the image display unit 28, image sensing can be done using the optical viewfinder 104 alone. In the optical viewfinder 104, some functions of the indication unit 54, e.g., an in-focus indication, camera shake alert indication, flash charging indication, shutter speed indication, aperture value indication, exposure correction indication, and the like are provided.

Reference numeral 110 denotes a communication circuit having various communication functions such as RS232C, USB, IEEE1394, P1284, SCSI, modem, LAN, radio communication, and the like.

Reference numeral 112 denotes a connector or antenna, which serves as a connector when the image processing apparatus 100 is connected to another device

using the communication means 139, or serves as an antenna in case of radio communications.

Reference numeral 120 denotes an interface for connecting the image processing apparatus 100 to the lens unit 300 in the lens mount 106; 122, a connector for electrically connecting the image processing apparatus 100 to the lens unit 300; and 124, a lens attachment/detachment detection circuit for detecting whether or not the lens unit 300 is attached to the lens mount 106 and/or the connector 122.

The connector 122 also has a function of exchanging control signals, status signals, data signals, and the like between the image processing apparatus 100 and lens unit 300, and supplying currents of various voltages. The connector 122 may communicate not only electrical signals but also optical signals, audio signals, and the like.

Reference numerals 130 and 132 denote mirrors which can guide light rays that have entered the lens 310 to the optical viewfinder 104 by the single-lens reflex system. Note that the mirror 132 may be either a quick return mirror or half mirror.

Reference numeral 200 denotes a recording medium such as a memory card, hard disk, or the like. The recording medium 200 comprises a recording unit 202 comprised of a semiconductor memory, magnetic disk, or

the like, an interface 204 with the image processing apparatus 100, and a connector 206 for connecting the image processing apparatus 100.

Reference numeral 210 denotes a recording medium
5 such as a memory card, hard disk, or the like. The recording medium 210 comprises a recording unit 212 comprised of a semiconductor memory, magnetic disk, or the like, an interface 214 with the image processing apparatus 100, and a connector 216 for connecting the
10 image processing apparatus 100.

Reference numeral 300 denotes an exchangeable lens type lens unit.

Reference numeral 306 denotes a lens mount for mechanically coupling the lens unit 300 to the image
15 processing apparatus 100. The lens mount 306 includes various functions of electrically connecting the lens unit 300 and image processing apparatus 100.

Reference numeral 310 denotes a photographing lens; and 312, a stop.

20 Reference numeral 320 denotes an interface for connecting the lens unit 300 to the image processing apparatus 100 in the lens mount 306; and 322, a connector for electrically connecting the lens unit 300 to the image processing apparatus 100. The connector
25 322 also has a function of exchanging control signals, status signals, data signals, and the like between the

image processing apparatus 100 and lens unit 300, and receiving or supplying currents of various voltages. Note that the connector 322 may communicate not only electrical signals but also optical signals, audio
5 signals, and the like.

Reference numeral 340 denotes a stop control circuit for controlling the stop 312 on the basis of photometry information from the photometry circuit 46 in cooperation with the shutter control circuit 40 that
10 controls the shutter 12.

Reference numeral 342 denotes a distance measurement control circuit for controlling focusing of the photographing lens 310; and 344, a zoom control circuit for controlling zooming of the photographing
15 lens 310.

Reference numeral 350 denotes a lens system control circuit for controlling the overall lens unit 300. The lens system control circuit 350 has a memory function of storing constants, variables, programs, and
20 the like required for operating the lens unit 300, and a nonvolatile memory function of holding identification information such as a number or the like unique to the lens unit 300, management information, function information such as a full-aperture value, minimum
25 aperture value, focal length, and the like, current and past setup values, and the like.

The operation of the image processing apparatus with the above arrangement will be explained below with reference to Figs. 2 to 9.

Figs. 2 to 6 are flow charts of the main routine showing the control sequence of the image processing apparatus 100.

Referring to Fig. 2, upon power ON after battery exchange or the like, the system control circuit 50 initializes flags, control variables, and the like and also performs required predetermined initial setups in the respective units of the image processing apparatus 100 (S101).

The system control circuit 50 checks the setup position of the power switch 72 (S102). If the power switch 72 is set at the power-OFF position, the system control circuit 50 executes a predetermined end process (S103). More specifically, the system control circuit 50 changes the indications of the respective indication units to an end state, records required parameters and setup values including flags, control variables, and the like, and the currently selected mode in the nonvolatile memory 56, cuts off unnecessary power supply to the respective units of the image processing apparatus 100 including the image display unit 28 by the power supply control circuit 80, and so forth. After that, the flow returns to step S102.

processing apparatus 100, in particular,
recording/playback of image data to/from the recording
medium 200 or 210 (S108). If any problem is found, a
predetermined alert indication is made by means of an
5 image or voice using the indication unit 54 (S105), and
the flow then returns to step S102.

If no problem is found, the flow advances to step
S109, and the system control circuit 50 checks the
setup state of the single/continuous shot switch 68
10 that sets the single/continuous shot mode (S109). If
the single shot mode is selected, the circuit 50 sets a
single/continuous shot flag to indicate the single shot
mode (S110); if the continuous shot mode is selected,
the circuit 50 sets the single/continuous shot flag to
15 indicate the continuous shot mode (S111). Upon
completion of flag setups, the flow advances to step
S112.

With the single/continuous shot switch 68, the
one-shot mode for sensing one frame of image upon
20 depression of the shutter switch SW2, and then setting
a standby state, and the continuous shot mode for
successively sensing images while the shutter switch
SW2 is held down can be arbitrarily selectively set.

Note that the state of the single/continuous shot
25 flag is stored in the internal memory of the system
control circuit 50 or the memory 52.

Referring to Fig. 3, the system control circuit 50 checks the setup state that pertains to the AE mode by the mode dial switch 60 (S112). If one of the shutter speed (Tv value) priority image sensing modes is selected, the system control circuit 50 sets an AE mode flag to indicate a Tv priority mode (S113); if one of the aperture (Av value) priority image sensing modes is selected, the circuit 50 sets the AE mode flag to indicate an Av priority mode (S114). Upon completion of flag setups, the flow advances to step S115.

The shutter speed (Tv value) priority image sensing modes include the sport image sensing mode and the like in addition to the shutter speed priority image sensing mode.

Also, the aperture (Av value) priority image sensing modes include the portrait image sensing mode, landscape image sensing mode, focal depth priority (depth) image sensing mode, and the like in addition to the aperture priority image sensing mode.

Note that the state of the AE mode flag is stored in the internal memory of the system control circuit 50 or the memory 52.

The system control circuit 50 checks the setup state of the AEB setup switch 66 that sets the AEB image sensing mode that performs automatic bracketing (S115). If the AEB image sensing mode is set, the

system control circuit 50 sets an AEB flag (S116), and also sets a correction step value (S117). The flow then advances to step S119.

On the other hand, if the AEB image sensing mode
5 is not set, the system control circuit 50 resets the AEB flag (S118), and the flow advances to step S119.

The correction step value can set an exposure step difference upon exposing three frames with a standard exposure value, overexposure value, and
10 underexposure value upon automatic bracketing. The correction step value normally uses values such as a 1/3 step, 1/2 step, 1 step, and the like.

Note that the state of the AEB flag and AEB correction step value are stored in the internal memory
15 of the system control circuit 50 or the memory 52.

If the AEB setup switch 66 is reset, the AEB correction step value is set at zero step, or predetermined setups for canceling image sensing during AEB image sensing are made, the system control circuit
20 50 determines that the setups for ending the AEB image sensing mode in the middle of the process are made (S119), and resets an AEB execution flag stored in its internal memory or the memory 52 (S121). The flow then returns to step S102.

25 If the setups for ending the AEB image sensing mode in the middle of the process are not made (S119),

the system control circuit 50 indicates various setup states of the image display apparatus 100 by means of an image or voice using the indication unit 54 (S120). When the image display of the image display unit 28 is
5 ON, various setup states of the image display apparatus 100 are indicated by means of an image also using the image display unit 28.

Referring to Fig. 4, if the shutter switch SW1 is OFF (S131), the flow returns to step S102.

10 If the shutter switch SW1 is ON (S131), the system control circuit 50 checks the state of the AEB execution flag stored in its internal memory or the memory 52 (S132). If the AEB execution flag is set, the system control circuit 50 determines that AEB image
15 sensing has already been started, and the flow advances to step S141.

If the AEB execution flag is reset (S132), the system control circuit 50 initializes a variable N to N = 0 (S133), and the flow then advances to step S134.

20 The system control circuit 50 executes a distance measurement/photometry process (S134). More specifically, the system control circuit 50 executes a distance measurement process for bringing the photographing lens 310 into focus on an object, and
25 also executes a photometry process to determine the aperture value and shutter speed. The flow then

advances to step S135. In the photometry process, the electronic flash is set if necessary.

The distance measurement/photometry process (S134) will be described in detail later with reference
5 to Fig. 7.

The system control circuit 50 checks the state of the AE mode flag stored in its internal memory or the memory 52 (S135), and determines a reference shutter speed used to compute the charge accumulation time of
10 the image sensing element 14 to be set in step S138 in correspondence with the state of the AE mode flag.

If the AE mode flag is set to indicate the Av priority mode (S135), the system control circuit 50 determines a value obtained by adding the correction
15 step value set in step S117 to the shutter speed (Tv value) obtained in step S134 to be the reference shutter speed based on which the charge accumulation time is computed (S136). The determined reference shutter speed corresponds to a shutter speed (slow
20 shutter speed) used to sense an image with an overexposure value in AEB image sensing.

In this manner, when the reference shutter speed is set at a shutter speed used to sense an image with an overexposure value, and the dark capture process is
25 done according to this speed, the shutter speed need not be changed for each of three frames upon executing

AEB image sensing in the aperture (Av value) priority image sensing mode. That is, even when the dark capture process is done for a longer period of time than the regular time, no problem is posed in a correction process based on that data, thus allowing such setups. Hence, the reference shutter speed may be set to be a value obtained by adding a value slightly larger than the correction step value set in step S117 to the shutter speed (Tv value) obtained by the distance measurement/photometry process (S134).

On the other hand, if the AE mode flag is set to indicate the Tv priority mode (S135), the system control circuit 50 determines the shutter speed (Tv value) obtained by the distance measurement/photometry process (S134) to be the reference shutter speed (S137).

In this manner, when the AE mode flag is set to indicate the Tv priority mode (shutter speed priority mode), since image sensing must be done for three frames at equal shutter speed upon AEB image sensing in the shutter speed priority mode, the shutter speed obtained by the distance measurement/photometry process (S134) is selected as the reference shutter speed used to compute the charge accumulation time.

The system control circuit 50 sets the charge accumulation time of the image sensing element 14 in accordance with the reference shutter speed determined

in step S136 or S137 (S138), and the flow advances to step S139.

Note that charge accumulation is made using the charge accumulation time set in this step in an image
5 sensing process (S164) and a dark capture process (S140 or S167), which will be described later.

The system control circuit 50 checks the state of the single/continuous shot flag stored in its internal memory or the memory 52 (S139). If the single shot
10 mode is set, the flow jumps to step S141.

In this manner, if it is determined in step S139 that the single shot mode is selected, the flow jumps to step S141 without executing a dark capture process (S140). With this control, a release time lag upon
15 depression of the shutter switch SW2 in step S141 can be reduced.

If the continuous shot mode is selected (S139), the system control circuit 50 executes a dark capture process (S140). That is, the system control circuit 50
20 accumulates noise components such as dark current and the like of the image sensing element 14 for the same period of time as that required for actual image sensing, while closing the shutter 12, and reads out the accumulated noise image signal. After that, the
25 flow advances to step S141.

The dark capture data captured in this dark capture process is used in a correction computation process later, and the correction process is made for image data that suffers image quality deterioration such as pixel omission or the like caused by dark current noise produced by the image sensing element 14 and scratches unique to the image sensing element 14.

The dark capture process (S140) will be described in detail later with reference to Fig. 9.

10 In this manner, if it is determined in step S139 that the continuous shot mode is set, the dark capture process (S140) is executed prior to continuous shot image sensing, thus setting nearly constant continuous shot frame intervals upon executing continuous shot image sensing by pressing the shutter switch SW2 in step S141.

The system control circuit 50 checks in step S141 if the shutter switch SW2 is ON. If the shutter switch SW2 is OFF, the system control circuit 50 repeats the current process until the shutter switch SW1 is turned off (S142).

If the shutter switch SW1 is turned off (S142), the flow returns to step S102.

If the shutter switch SW2 is ON (S141), the system control circuit 50 checks if an area that can store sensed image data is available on an image

storage buffer area on the memory 30 (S161), as shown
in Fig. 5. If no area that can store sensed image data
is available on the image storage buffer area on the
memory 30, a predetermined alert indication is made by
5 means of an image or voice using the indication unit 54
(S162), and the flow then returns to step S102.

For example, the user experiences such state
immediately after he or she has executed continuous
shot image sensing corresponding to a maximum number of
10 images that can be stored in the image storage buffer
area. In this state, the first image to be read out
from the memory 30 and written in the recording medium
200 or 210 is not recorded on the recording medium 200
or 210 yet, and a free area even for one image cannot
15 be assured on the image storage buffer area on the
memory 30.

When sensed image data is stored in the image
storage buffer area on the memory 30 after it is
compressed, it is checked in step S161 if an area that
20 can store sensed image data is available on the image
storage buffer area on the memory 30, in consideration
of the fact that the compressed image data size varies
depending on the setups of the compression mode.

If an area that can store sensed image data is
25 available on the image storage buffer area on the
memory 30 (S161), the system control circuit 50 checks

the state of the AEB flag stored in its internal memory or the memory 52 (S181). If the AEB flag is set, the flow advances to step S163; otherwise, the flow jumps to step S164.

5 In step S163, the system control circuit 50 sets the AEB execution flag. Note that the state of the AEB execution flag is stored in the internal memory of the system control circuit 50 or the memory 52.

10 The system control circuit 50 then checks the value of the variable N. If $N = 0$, the system control circuit 50 sets AEB correction photometry data for underexposure, and stores it in its internal memory or the memory 52 (S182).

15 If $N = 1$, the system control circuit 50 sets AEB correction photometry data for standard exposure and stores it in its internal memory or the memory 52 (S183).

20 If $N = 2$, the system control circuit 50 sets AEB correction photometry data for overexposure and stores it in its internal memory or the memory 52 (S184).

25 The system control circuit 50 then executes an image sensing process (S164). More specifically, the system control circuit 50 reads out a sensed image signal, which has been accumulated for a predetermined period of time upon image sensing, from the image sensing element 14, and writes the sensed image data on

the predetermined area of the memory 30 via the A/D converter 16, image processing circuit 20, and memory control circuit 22, or from the A/D converter 16 directly via the memory control circuit 22.

5 The image sensing process (S164) will be explained in detail later using Fig. 8.

 Upon completion of the image sensing process (S164), the system control circuit 50 checks the state of the AEB flag stored in its internal memory or the
10 memory 52 (S185). If the AEB flag is set, the flow advances to step S165; otherwise, the flow jumps to step S166.

 In step S165, the system control circuit 50 updates the variable N to $N = N + 1$, and the flow then
15 advances to step S166.

 The system control circuit 50 checks the state of the single/continuous shot flag stored in its internal memory or the memory 52 (S166). If the continuous shot mode is set, the flow advances to step S168.

20 If it is determined in step S166 that the continuous shot mode is set, since the dark capture process has already been done in step S140 prior to continuous shot image sensing, a development process (S168) is executed without executing another dark
25 capture process in step S167. In this manner, nearly constant continuous shot frame intervals can be set.

5 If the single shot mode is set (S166), the system control circuit 50 executes the dark capture process for accumulating noise components such as dark current and the like of the image sensing element 14 for the same period of time as that required for actual image sensing, while closing the shutter 12, and reading out the accumulated noise image signal (S167). The flow then advances to step S168.

10 By making a correction computation process later using dark image data captured by the dark capture process, image data that suffers image quality deterioration such as pixel omission or the like caused by dark current noise produced by the image sensing element 14 and scratches unique to the image sensing
15 element 14 can be corrected.

The dark capture process (S167) will be described in detail later using Fig. 9.

20 In this manner, if it is determined in step S166 that the single shot mode is set, the dark capture process (S167) is executed after the image sensing process (S164), thus reducing the shutter release time lag (the time lag from when SW2 is pressed until image sensing starts actually) upon depression of the shutter switch SW2 in step S141.

25 In step S168 in Fig. 6, the system control circuit 50 reads out some of image data written in the

predetermined area of the memory 30 via the memory control circuit 22, executes a WB (white balance) integral computation process and OB (optical black) integral computation process required to execute development processes, and stores the computation results in its internal memory or the memory 52.

The system control circuit 50 then reads out sensed image data written in the predetermined area of the memory 30 using the memory control circuit 22 and the image processing circuit 20 as needed, and executes various development processes including AWB (auto white balance) process, gamma conversion, color conversion, and the like using the computation results stored in its internal memory or the memory 52.

Furthermore, in the development processes, the system control circuit 50 also executes a dark correction computation process for canceling dark current noise and the like of the image sensing element 14 by executing a subtraction process using the dark image data captured in the dark capture process.

The system control circuit 50 reads out image data written in the predetermined area of the memory 30, makes the compression/expansion circuit 32 execute an image compression process in accordance with the selected mode (S169), and writes the obtained image

data in a free image space of the image storage buffer area on the memory 30.

Upon executing a series of processes, the system control circuit 50 executes a recording start process (S170). That is, the system control circuit 50 reads out image data stored in the image storage buffer area of the memory 30, and begins to write the readout image data in the recording medium 200 or 210 such as a memory card, compact flash card, or the like.

10 This recording start process is executed for new image data, which has been sensed and undergone a series of processes, every time that image data is written in a free image space of the image storage buffer area on the memory 30.

15 While a write of image data in the recording medium 200 or 210 is underway, a recording medium write access indication (e.g., flashing an LED of the indication unit 54) is made to clearly indicate that write access.

20 The system control circuit 50 checks the state of the AEB flag stored in its internal memory or the memory 52 (S186). If the AEB flag is set, the flow advances to step S171; otherwise, the flow jumps to step S173.

25 The system control circuit 50 checks in step S171 if the variable N has reached $N = 3$. If the variable N

has reached $N = 3$, the system control circuit 50 resets the AEB execution flag (S172), and the flow returns to step S102.

If the variable N has not reached $N = 3$ yet (S171), the system control circuit 50 checks the state of the single/continuous shot flag stored in its internal memory or the memory 52 (S173). If the continuous shot mode is set, the flow returns to step S141 to proceed with image sensing, thus making the next image sensing.

If the single shot mode is set, the system control circuit 50 checks if the shutter switch SW1 is ON (S174).

If the shutter switch SW1 is ON (S174), the system control circuit 50 repeats the current process until the shutter switch SW1 is turned off. If the shutter switch SW1 is OFF (S174), the flow returns to step S102.

Fig. 7 is a flow chart showing the detailed sequence of the distance measurement/photometry process in step S134 in Fig. 4. In the distance measurement/photometry process, the system control circuit 50 and the stop control circuit 340 or distance measurement control circuit 342 exchange various signals via the interface 120, connectors 122 and 322, interface 320, and lens control circuit 350.

The system control circuit 50 starts an AF (auto-focus) process using the image sensing element 14, distance measurement circuit 42, and distance measurement control circuit 342 (S201).

5 The system control circuit 50 executes AF control for checking the focusing state of an image formed as an optical image by guiding light rays, which have entered the lens 310, to the distance measurement circuit 42 via the stop 312, lens mounts 306 and 106,
10 mirror 130, and distance measurement sub-mirror (not shown), and detecting the focusing state using the distance measurement circuit 42 while driving the lens 310 using the distance measurement control circuit 342 (S202), until the distance measurement (AF) result
15 indicates an in-focus (S203).

If the distance measurement (AF) result indicates an in-focus (S203), the system control circuit 50 determines an in-focus distance measurement point from those in an image sensing screen (S204), and stores
20 distance measurement data and/or setup parameters in its internal memory or the memory 52 together with the determined distance measurement point data. The flow then advances to step S205.

Subsequently, the system control circuit 50
25 starts an AE (auto-exposure) process using the photometry circuit 46 (S205).

5 The system control circuit 50 clears charge on the image sensing element 14 (S303), then starts charge accumulation of the image sensing element 14 (S304), opens the shutter 12 by the shutter control circuit 40 (S305), and starts exposure of the image sensing element 14 (S306).

10 The system control circuit 50 checks based on the flash flag if the electronic flash 48 is required (S307), and if the electronic flash 48 is required, the circuit 50 controls the electronic flash 48 to emit light (S308).

15 The system control circuit 50 waits for the end of exposure of the image sensing element 14 in accordance with the photometry data if the AEB flag is not set, or the AEB correction photometry data if the AEB flag is set (S309), closes the shutter 12 by the shutter control circuit 40 (S310), and ends exposure of the image sensing element 14.

20 The system control circuit 50 drives the stop 312 to a full-open aperture value by the stop control circuit 340 (S311), and moves the mirror 130 to a mirror down position by the mirror driving circuit (not shown) (S312).

25 If the determined charge accumulation time has elapsed (S313), the system control circuit 50 reads out a charge signal from the image sensing element 14 upon

completion of charge accumulation of the image sensing
element 14 (S314), and writes sensed image data in a
predetermined area of the memory 30 via the A/D
converter 16, image processing circuit 20, and memory
control circuit 22, or from the A/D converter 16
5 directly via the memory control circuit 22 (S315).
Upon completion of a series of processes, the image
sensing process routine (S164) ends.

Fig. 9 is a flow chart showing the detailed
10 sequence of the dark capture process in step S140 in
Fig. 4 and in step S167 in Fig. 5.

The system control circuit 50 clears charge on
the image sensing element 14 (S401), and then starts
charge accumulation of the image sensing element 14
15 while the shutter 12 is closed (S402).

If the predetermined charge accumulation time has
elapsed (S403), the system control circuit 50 ends
charge accumulation of the image sensing element 14
(S404), then reads out a charge signal from the image
sensing element 14, and writes image data (dark image
20 data) in a predetermined area of the memory 30 via the
A/D converter 16, image processing circuit 20, and
memory control circuit 22, or from the A/D converter 16
directly via the memory control circuit 22 (S405).

25 By executing the development process using this
dark capture data, sensed image data can be corrected

for image quality deterioration such as pixel omission or the like caused by dark current noise produced by the image sensing element 14 and scratches unique to the image sensing element 14.

5 Note that this dark image data is held in the predetermined area of the memory 30 until a new distance measurement/photometry process is done or the power switch of the image processing apparatus 100 is turned off.

10 This dark image data is used when the next image sensing process is done, and image data sensed by that process is read out to execute the development process.

 Or when image data sensed by the image sensing process and read out from the image sensing element 14
15 has already been written in the memory 30, the development process is executed using dark image data.

 Upon completion of a series of processes, the dark capture process routine (S140 and S167) ends.

 Fig. 10 is a timing chart showing the flow of
20 image sensing operation in the aforementioned embodiment.

 In the above embodiment, the exposure values upon AEB image sensing are set to sense images in the order of underexposure, standard exposure, and overexposure.
25 However, the present invention is not limited to such specific order, and the exposure values may be set to

sense images in any other orders such as in the order
of standard exposure, underexposure, and overexposure,
of standard exposure, overexposure, and underexposure,
of overexposure, standard exposure, and underexposure,
5 and the like.

In the above embodiment, in continuous shot AEB
image sensing, immediately after the dark capture
process is executed once, images with underexposure,
standard exposure, and overexposure values are sensed.
10 In single shot AEB image sensing, a total of three dark
capture processes are executed every time each of
images with underexposure, standard exposure, and
overexposure values is sensed. Instead, in both
continuous shot AEB image sensing and single shot AEB
15 image sensing, the dark capture process may be executed
once in correspondence with the longest charge
accumulation time.

In this case, in single shot AEB image sensing,
the dark capture process is executed once in
20 correspondence with the longest charge accumulation
time in the first image sensing operation, and dark
correction computations are made using the first dark
capture data without executing any dark capture process
in the second and third image sensing operations. With
25 this control, the image sensing interval for the second

and subsequent frames upon single shot AEB image sensing can be shortened.

In the above embodiment, the single or continuous shot mode is selected using the single/continuous shot switch 68. Alternatively, the single or continuous shot mode may be selected in correspondence with the operation mode selected by the mode dial switch 60.

The AEB image sensing mode and AEB correction step value are simultaneously set by the AEB setup switch. Alternatively, the AEB image sensing mode and AEB correction step value may be independently set at quite different timings.

In this case, independent operation switches may be used to independently set the AEB image sensing mode and AEB correction step value.

In the above description, the AE mode is set in correspondence with the image sensing mode set by the mode dial switch 60. Alternatively, an AE mode setup switch may be added, and the AE mode may be set independently of the mode dial switch 60.

In the above description, the number of frames to be sensed in AEB image sensing is three. However, the present invention is not limited to such specific number of frames, as long as a plurality of frames are sensed.

Also, the correction step value in AEB image sensing need not be constant for the respective frames to be sensed. For example, the step value between the standard and overexposure values may be set at 1/2 step, and that between the standard exposure value and underexposure value may be set at 1/3 step.

Such different correction step values may be set by the user of the image sensing apparatus 100.

Furthermore, the image sensing apparatus 100 itself may set different values for the overexposure and underexposure sides in accordance with grayscale characteristics unique to the image sensing element 14 to improve the AEB image sensing effect.

In the above embodiment, the charge accumulation time of the actual image sensing process is set to be equal to that of the dark capture process. However, different charge accumulation times may be set as long as sufficient data that can be used to correct dark current noise and the like can be obtained.

During execution of the dark capture process in steps S140 and S167, since image sensing cannot be done, a visual or audio message indicating that the image processing apparatus 100 is busy may be made using the indication unit 54 and/or image display unit 28.

In the above embodiment, image sensing is done by moving the mirror 130 between the mirror up and down

positions. However, the mirror 130 may comprise a half mirror, and image sensing may be done without moving the mirror.

5 The recording media 200 and 210 are not limited to memory cards such as PCMCIA cards, compact flash cards, or the like, hard disks, and the like, but may use micro DATs (digital audio tapes), magnetooptical disks, optical disks such as CD-Rs, CD-WRs, or the like, phase change optical disks such as DVDs, and the like.

10 Also, the recording media 200 and 210 may use hybrid media that integrate memory cards, hard disks, and the like. Furthermore, such hybrid media may include detachable media.

15 In the above embodiment, the recording media 200 and 210 are independent from the image processing apparatus 100 and are arbitrarily connectable. One or both the recording media 200 and 210 may be permanently connected to the image processing apparatus 100.

20 An arbitrary number (one or a plurality) of image recording media 200 or 210 may be connectable to the image processing apparatus 100.

25 In the above description, the recording media 200 and 210 are attached to the image processing apparatus. However, one or a combination of a plurality of recording media may be used.

Note that the present invention may be applied to either a system constituted by a plurality of devices, or an apparatus consisting of a single equipment.

The objects of the present invention are also
5 achieved by supplying a storage medium, which records a program code of a software program that can implement the functions of the above-mentioned embodiments to the system or apparatus, and reading out and executing the program code stored in the storage medium by a computer
10 (or a CPU or MPU) of the system or apparatus.

In this case, the program code itself read out from the storage medium implements the functions of the above-mentioned embodiments, and the storage medium which stores the program code constitutes the present
15 invention.

As the storage medium for supplying the program code, for example, a floppy disk, hard disk, optical disk, magnetooptical disk, CD-ROM, CD-R, magnetic tape, nonvolatile memory card, ROM, and the like may be used.

20 The functions of the above-mentioned embodiments may be implemented not only by executing the readout program code by the computer but also by some or all of actual processing operations executed by an OS (operating system) running on the computer on the basis
25 of an instruction of the program code.

Furthermore, the functions of the above-mentioned
embodiments may be implemented by some or all of actual
processing operations executed by a CPU or the like
arranged in a function extension board or a function
5 extension unit, which is inserted in or connected to
the computer, after the program code read out from the
storage medium is written in a memory of the extension
board or unit.

The embodiments of the present invention have
10 been described. However, the present invention is not
limited to the arrangements of such embodiments, but
may be applied to any other arrangements as long as
they may achieve functions defined in the appended
claims or functions of the arrangements of the
15 embodiments.

The software and hardware arrangements of the
above embodiments can be appropriately replaced.

The present invention may be achieved by
combining the above embodiments or their technical
20 components as needed.

The present invention may be applied even when
all or some of claims or the arrangements of the
embodiments form a single apparatus, are combined with
another apparatus, or are building components of the
25 apparatus.

The present invention can be applied to various types of cameras such as an electronic still camera, video movie camera, a camera using a silver halide film, and the like, image sensing apparatuses other than
5 cameras, devices applied to such cameras and image sensing apparatuses, and building components of those devices.

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